African Journal of Agricultural Research Vol. 7(2), pp. 320-324, 12 January, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.1668
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Gender´s efficiency in Mediterranean greenhouse agricultural labor

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Accepted 7 December, 2011

In every economy, there are wage differentials depending on gender and profession. On average, women earn less than men, and this is attributed to two factors: differences in productivity and discrimination. So far, productivity by gender has been indirectly measured through production functions. For this project, we used time-study techniques to directly measure gender productivity in greenhouse agricultural tasks. Labor is a key factor in the development and maintenance of the greenhouse cultivation industry, as it represents approximately 40% of the running costs of a typical operation. The data correspond to fifty workers over three growing seasons from 2006 to 2007 and 2008 to 2009 for greenhouse sweet pepper cultivation in Spain. The results have shown that women have a 12% better average efficiency over men, and that this efficiency is also evident in all of the repetitive tasks of the cultivation. For the tasks we analyzed, a women-only workforce could mean a 16% reduction in labor hours. Given that women have both better average efficiency overall and better efficiency in work that must be repeated several times during a growing season; this being the type of work that accounts for the most labor hours and that labor is the greatest expense in greenhouse cultivation, it seems that female labor will become increasingly necessary to maintain this agricultural sector.

Key words: Gender, productivity, labor, time study techniques, standard times.

INTRODUCTION

In every economy, there are wage differentials depending on gender and profession, although they vary in magnitude; globally, considering a large group of occupations, there is a gap between average male and female remuneration, with women on average earning less than men (Robinson, 1998). The gender earnings differentials may be attributed to two factors: differences in labor productivity between men and women and market (employer, employee, and customer) discrimination against women (Becker, 1957). It was later realized that gender segregation in occupations, industries, firms, and jobs is also an important source of existing gender wage differences (Groshem, 1990; Meng, 2004,).

The efficiency of women farmers in the agricultural sector of developing countries is passionately debated (Adesina and Djato, 1997). Recent studies in Bangladesh attribute lower wages to women due in part to lower productivity and discrimination (Ahmed and Maitra, 2010). Women are suffering from market discrimination and hence are pushed toward separate low-paid and low-status jobs; furthermore, the rate of unemployment among women is consistently higher than that of men, both in rural and urban areas of Pakistan (Sadaquat and Sheikh, 2011).

Testing for productive efficiency between men and women in Burkina Faso shows, on average, that women achieve much higher values of output per hectare than those of men, on much smaller plots (Udry et al., 1995). Women are considered not only to have naturally nimble fingers, but also to be naturally more docile and willing to accept tough work discipline, and naturally more suited to tedious, repetitious, monotonous work (Elson and Pearson, 1981). Linking female labor with repetitive tasks based on manual skill, falls within female work stereotypes

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and can create gender-based labor differences (Alario et al., 2008).

Most recent studies on the productivity gap between men and women in agricultural tasks show significant differences in agricultural productivity depending on gender (Anyaegbunam et al., 2010). Research has illustrated how farms purposefully construct gendered divisions of labor and how women often experience worse pay and conditions than men (Selwyn, 2010). More recently, Reddy (2007) documents how in Indian agriculture new biological techniques have increased the number of women in the production process, but, interestingly, that managers' use of the 'nimble fingers' explanation to justify their employment strategy obscured their objective of securing regular supplies of docile, cheap, and non-politicized (non-unionized) labor. So far, studies to determine the efficiency or productivity differences between men and women are based on profit functions and show that the relative degree of efficiency of women is similar to that of men (Adesina and Djato, 1997); other studies show, in general, an average efficiency in agricultural work of 90% (Rahman, 2010).

Female labor in Spain is usually concentrated in the services industry at more than 80%. Agriculture is no longer a working option for women, except in some livestock specialist areas (Cantabrian Mountains and Galicia) or intensive agriculture (Andalucía and Levante), where the presence of women has always been important (Alario et al., 2009).

So far, studies on women in agricultural work are based on studying the efficiency of women associated with obtaining the final production quantity. This may be affected by agronomic variables such as the quality of land, seeds, water, etc. In this paper, we consider applying time-study techniques to directly measure the efficiency of women in greenhouse agricultural work. Time-study techniques began with Frederick Taylor, who developed a system based on the concept of task (Taylor, 1911); thus, each task should have a set performance standard (Niebel and Andris, 2003), defined as the time required for an average worker, fully qualified and trained, and working at a normal speed, to perform an operation. The determination of standard times in greenhouse agricultural work is necessary for efficient work planning, as they can show variations in performance (Luxhoj and Giacomelli, 1990). Time-study techniques have been applied to labor management in greenhouse tomato cultivation (*Solanum lycopersicum*), establishing standard times for the tasks of tomato cultivation, and allowing labor planning prior to the necessities of cultivation (Manzano-Agugliaro and García-Cruz, 2009).

Nowadays, the total surface for greenhouses and macro tunnels in the world is around 1.6×10^6 ha, and 80% of them are concentrated in eastern Asia. The other great concentration is found in the Mediterranean area, with 0.19×10^6 ha (Agugliaro, 2007). Some of the largest concentrations of greenhouses in the Mediterranean are in the coastal areas of Almería, Murcia and Granada, in southeastern Spain, with approximately 37,500 ha mainly dedicated to intensive vegetable production (Manzano-Agugliaro and Cañero-Leon, 2010). The greenhouse area on the coast of Almería is stabilized at around 27,000 ha (Callejón-Ferre et al., 2010). In developing countries, the main greenhouse cultivation cost is labor, which represents about 40% of total expenses (IEC, 2010), as two workers are necessary, on average, for each greenhouse hectare (Callejón-Ferre et al., 2010; Manzano-Agugliaro and García-Cruz, 2009). The total worldwide labor in greenhouses is approximately 3.2×10^6 daily jobs.

MATERIALS AND METHODS

Description of the working environment and data capture

The study was conducted in a metal-framed, multi-tunnel greenhouse with 5 m ridge height and 4 m side height; 115,000 m^2 surface, with 732 m length of the major axis, 238 m width of the west side and 94 m of the east side (Figure 1); it is located in Almería (Spain), on the coordinates 136° 49' N and 2° 09' W referred to the WGS84 datum.

The greenhouse was divided into 356 numbered work areas, with an average surface of 320 m^2, the smallest being 280 m^2 and the largest 360 m^2, with lengths varying between 35 to 45 m. Thirty remote terminals, which were controlled by a worker for a given task, were installed in the central walkways to capture data. At the beginning of the task, the worker introduces the following data in the closest terminal to the work zone: operator code, work zone and task to be performed. Once the task is finished, the worker types their operator code in the terminal again, thus closing the open registry. Terminals are connected through an RS232 cable to a central computer, which stores time registrations, start and end dates for each task, zone and worker. Then, the data are converted into yields (m^2 h^{-1}) based on the surface of each area and the time spent by the worker on that task.

Analyzed tasks

The different tasks performed by workers have been broken down in Table 1. They have been registered for three growing seasons (2006 to 2007, 2007 to 2008 and 2008 to 2009) for the "California"-type pepper cultivation (*Capsicum annum L.*), the planting of which begins early in order to extend the crop cycle, and avoid, as well as possible, the onset of setting problems when nocturnal temperatures begin to fall excessively. Cultivation usually starts in July. The beginning of production is between September and October, and harvesting ends with the arrival of the cold at the end of January and February. The planting grid is 1.33 m between rows and 0.24 m between plants, which means a density of 3.13 plants per square meter.

Calculation of global average and standard times

Standard performance (ρ_s) was calculated based on the work of Manzano-Agugliaro and García-Cruz (2009), taking the average performances of the eight best workers involved in the task, and omitting those whose number of registrations was below the 50th

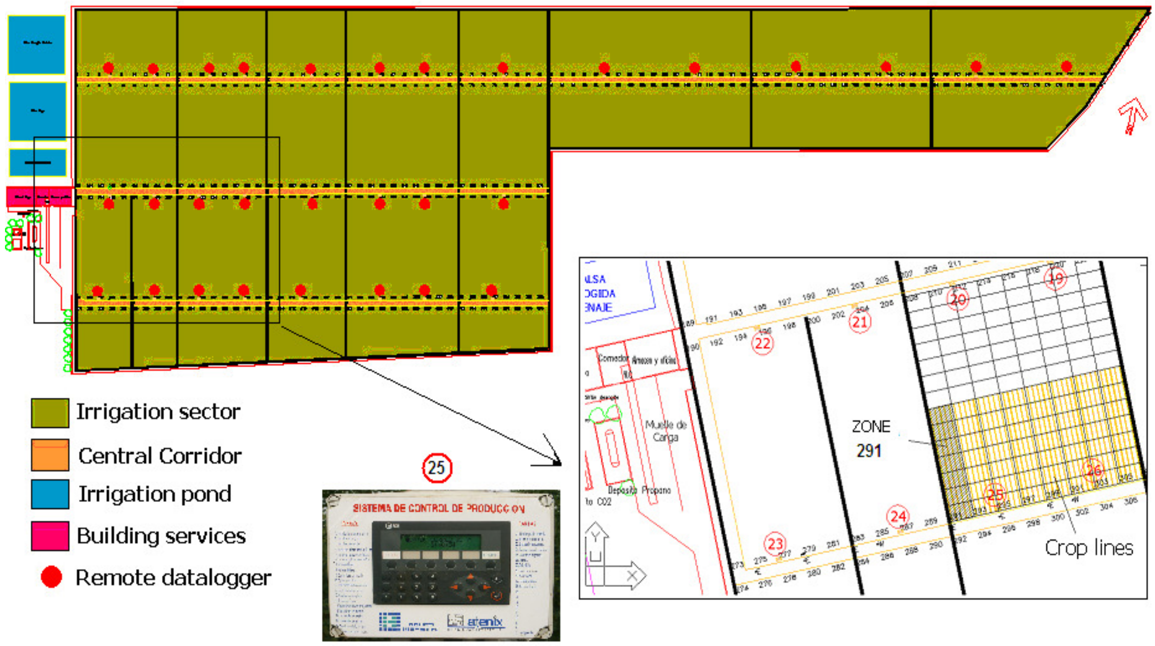

Figure 1. Greenhouse plant distribution and detail of work zone.

Table 1. Description of agricultural tasks studied in sweet pepper cultivation.

Nº	Task description
1	Removal of secondary stems, which emerge from under the leaves, when the plants are <1 m high.
2	Removal of secondary stems, which emerge from under the leaves, when the plants are between 1 and 2 m high.
3	Removal of secondary stems, which emerge from under the leaves, when the plants are more than 2 m high.
4	Tying, looping or pinching the main stem of the plant to a string or nylon cord anchored at the top to a sliding steel strap, when the plant is <1 m high.
5	Tying, looping or pinching the main stem of the plant to a string or nylon cord anchored at the top to a sliding steel strap, when the plant is between 1 and 2 m high.
6	Tying, looping or pinching the main stem of the plant to a string or nylon cord anchored at the top to a sliding steel strap, when the plant is more than 2 m high.
7	Cutting and collection of fruit, placing them in boxes, and leaving the boxes in the central corridors.

percentile; thus, the more experienced workers were selected, and discarding the best worker of that group.

Calculating the average performances (ρ_m) for each task, expressed in square meters per hour ($m^2 \cdot h^{-1}$), as the arithmetic mean of the performances of all workers involved in this task during the three growing seasons. The gender average performance was calculated using the same method, but with the men and women separated.

RESULTS

According to the methodology described, Table 2 shows the results of the variables measured for the set of workers, successively in columns as follows: task number, workers who participated in the task during the three growing seasons, total number of records analyzed (n), average performance (ρ_m), standard deviation of average performance (σ_{ρ_μ}),performance standard (ρ_s), work efficiency (e) calculated as the percentage of the performance standard reached by the average performance ($e = \rho_m \cdot 100 \cdot \rho_s^{-1}$), the number of times that the task was repeated in the same zone during a growing season (N), standard time (t_s) calculated as $t_s = 10.000\ \rho_s^{-1} \cdot N$, average time ($t_m$) calculated as $t_m = 10.000 \cdot \rho_m^{-1} \cdot N$, expressing the latter two parameters in $h \cdot ha^{-1}$.

Table 3 breaks down the results in Table 2, taking into account the workers´ gender. Thus, the first column shows the number of workers of each gender involved in a given task; the second column, the average performance by gender; the third column, efficiency by gender compared to the standard performance in Table 2; the fourth column, the total average time spent in a

Table 2. Performances and times (average and standard) for greenhouse sweet pepper cultivation tasks. With *nw* (number of workers that participated in the task during the three cycles), *n* (total number of records analyzed), ρ_m (average performances), σ_{ρ_μ} (standard deviation of average performances), ρ_s (standard performance), *e* (efficiency), *N* (number of times that the same task was repeated in a zone during a cycle), *ts* (standard time), t_m (average time).

Task number	$n_{w=} \sum_{06-07}^{08-09} n_w$	$n_{\rho_\mu} \sum_{06-07}^{08-09} n$	ρ_m ($m^2 \cdot h^{-1}$)	σ_{ρ_μ} ($m^2 \cdot h^{-1}$)	ρ_s ($m^2 \cdot h^{-1}$)	e (%)	N	t_s (h· ha^{-1})	t_m (h· ha^{-1})
1	31	167	136.19	44.8	155.84	87.39	1	64.2	73.4
2	27	403	217.30	66.95	230.75	94.17	1	43.3	46.0
3	30	170	193.75	46.28	225.63	85.87	1	44.3	51.6
4	43	636	103.36	32.76	120.37	85.87	2	166.2	193.5
5	44	639	202.07	41.61	230.73	87.58	3	130.0	148.5
6	20	363	318.73	42.01	356.08	89.51	1	28.1	31.4
7	50	3577	423.37	158.02	439.91	96.24	20	454.6	472.4
					m =	**89.52**	Σ =	930.7	1016.8

Table 3. According to the gender of the worker, average performance (ρ_μ) and number of registrations and workers for the greenhouse´s sweet pepper cultivation tasks during the three growing seasons.

Task	$n_{w=} \sum_{06-07}^{08-09} n_w$		ρ_μ (m^2 h^{-1})		e (%)		t_m h· ha^{-1}		Δt_m h· ha^{-1}
	Women	Men	Women	Men	Women	Men	Women	Men	W-M
1	10	21	123.14	149.24	79.02	95.77	81.2	67.0	14.2
2	13	14	177.10	257.50	76.75	111.59	56.5	38.8	17.6
3	10	20	311.98	75.53	138.27	33.48	32.1	132.4	-100.3
4	15	28	107.40	99.33	89.22	82.52	186.2	201.3	-15.1
5	23	21	231.56	172.58	100.36	74.80	129.6	173.8	-44.3
6	13	7	292.57	344.89	82.16	96.86	34.2	29.0	5.2
7	22	28	443.38	403.35	100.79	91.69	451.1	495.8	-44.8
				m =	95.22	83.81	970.8	1138.3	-167.5

given task by gender, that is, considering the number of times that it is repeated throughout the crop cycle; and, finally, the last column shows the differences, in total hours per hectare of greenhouse, by gender.

DISCUSSION

We observe that the selected workers have experience in the job, as their efficiency is close to 90% and that, above all, the task that is repeated the most often and that therefore requires the highest efficiency – task number 7, collecting fruit – is the one with best result (96%). Rahman (2010) is of the opinion that farm profitability could be improved through labor efficiencies of around 90%. In our case, however, we understand that seasonal or temporary labor makes it difficult to exceed this threshold.

In comparing average performances by gender, we observe that, depending on the task, one gender performs better than the other. This could lead to a segregation of tasks as happens in other types of industry (Meng, 2004). Nevertheless, the piece of data that might be of particular interest to an employer is the average time spent, expressed in h· ha^{-1} of crop, for a particular task depending on the worker, and in our case, on gender. In this sense, we must take into account the number of times that the task is repeated; thus, it has been observed that 16% of the hours required to perform these tasks could have been saved if they had been performed exclusively by women. On the other hand, if we consider the average efficiency as the average of the efficiency of all of the tasks analyzed, the figure for women is higher by 12%. Although it is difficult to compare these results, since there are no published data on performance in greenhouse agricultural tasks by gender, we can say that other authors also conclude that women are better suited to monotonous and repetitive work than men (Elson and Pearson, 1981), despite the fact that this can be considered a stereotype for women (Alario et al., 2008). The results of this study show higher efficiency in women, and also better performance than men in all repetitive farm tasks, thus being consistent with the suggestions of other authors. However, we believe that it should be seen not as a stereotype but simply for what it is: greater efficiency resulting in higher job performance and cost savings for the employer.

In our zone of study, the average area of greenhouse cultivation is from 1 to 2 ha (Manzano-Agugliaro and Cañero-Leon, 2010), requiring, on average, 2.2 workers per hectare (Manzano-Agugliaro and García Cruz, 2009). This does not allow for changing workers according to the task, as it is shown that labor stability is one of the factors that most affect productivity (Auer et al., 2005). Given that women have both better average efficiency overall and better efficiency in work that must be repeated several times during a growing season; this being the type of work that accounts for the most labor hours and that labor is the greatest expense in greenhouse cultivation, it seems that female labor will become increasingly necessary to maintain this agricultural sector.

Conclusions

In this study, we have measured and analyzed the productivity gap in greenhouse agricultural tasks by worker gender, using time-study techniques applied to greenhouse sweet pepper cultivation. The results have shown that women have a 12% better average efficiency over men, and that this efficiency is also evident in all of the repetitive tasks of the cultivation. For the tasks we analyzed, a women-only workforce could mean a 16% reduction in labor hours. Given that women have both better average efficiency overall and better efficiency in work that must be repeated several times during a growing season; this being the type of work that accounts for the most labor hours and that labor is the greatest expense in greenhouse cultivation, it seems that female labor will become increasingly necessary to maintain this agricultural sector.

REFERENCES

Adesina AA, Djato KK (1997). Relative efficiency of women as farm managers: profit function analysis in Cote d'Ivoire. Agric. Econ., 16: 47-53.

Alario M, Pascual H, Baraja E (2009). Occupational segregation of women in rural Industry: The case of Castilla y León. Boletín de la Asociación de Geógrafos Españoles, 50: 173-192.

Alario M, Baraja E, Pascual H (2008). Género y espacio: la inserción laboral de las mujeres rurales. In Mujeres Rurales. Estudios Interdisciplinares de Género (Maya Frades, V., coord.). Salamanca, Universidad de Salamanca, pp. 61-80.

Agugliaro FM (2007). The gasification of vegetable residues of greenhouses for making electrical energy in the south of Spain: his location study by GIS. Interciencia, 32(2): 131-136.

AHMED S, MAITRA P (2010). Gender wage discrimination in rural and urban labour markets of Bangladesh. Oxford Dev. Stud., 38(1): 83-112.

Anyaegbunam HN, Okoye BC, Asumugha GN, Ogbonna MC, Madu TU, Nwakor N, Ejechi ME (2010). Labour productivity among small-holder cassava farmers in South East agro ecological zone, Nigeria. Afr. J. Agric. Res., 5(21): 2882-2885.

Auer P, Berg J, Coulibaly I (2005). Is a stable workforce good for productivity? Int. Labour Rev., 144(3): 319-343.

Becker GS (1971). The Economics of Discrimination. University of Chicago Press, Chicago, p. 167.

Callejon-Ferre AJ, Manzano-Agugliaro F, Diaz-Perez M, Carreno-Sanchez J (2011). Improving the climate safety of workers in Almería-type greenhouses in Spain by predicting the periods when they are most likely to suffer thermal stress. Appl. Ergon., 42(2): 391-396.

Elson D, Pearson R (1981). 'Nimble Fingers Make Cheap Workers: An Analysis of Women's Employment in Third World Export Manufacturing'. Fem. Rev., 7(1): 87-101.

Groshen EL (1990). The structure of the female/male wage differential: is it who you are, what you do, or where you work?'' J. Hum. Res., 26(3): 457-472.

IEC (Instituto de Estudios de Cajamar) (2010). Análisis de la Campaña Hortofrutícola de Almería. Campaña 2009/2010. Ed. Caja Rural Intermediterranea. Cajamar. Almería, pp. 28-33.

Luxhoj JT, Giacomelli GA (1990). Comparison of Labour Standards for a Greenhouse Tomato Production System: A Case Study. Inter. J. Opera. Prod. Manage., 10(3): 38-49.

Manzano-Agugliaro F, Cañero-Leon R (2010). Economics and environmental analysis of Mediterranean greenhouse crops. Afr. J. Agric. Res., 5(22): 3009-3016.

Manzano-Agugliaro F, García-CRUZ A (2009). Time study techniques applied to labor management in greenhouse tomato (*Solanum lycopersicum* L.) cultivation. Agrociencia, 43(3): 267-277.

Meng X (2004). Gender earnings gap: The role of firm specific effects. Labour Econ., 11: 555-573.

Niebel B, Andris F (2003). Methods, Standards and Work Design. Ed. McGraw Hill. New York, p. 776.

Rahman S (2010). Women's labour contribution to productivity and efficiency in agriculture: empirical evidence from Bangladesh. J. Agric. Econ., 61(2): 318-342.

Reddy C (2007). Plant Tissue Culture Industry and Women's Participation: Nimble Fingers or Docile Labour?. Gend. Technol. Dev., 11(2): 179-198.

Robinson D (1998). Differences in occupational earnings by sex. Int. Labour Rev., 137(1): 3-31.

Sadaquat MB, Sheikh QA (2011). Employment situation of women in Pakistan. Int. J. Soc. Econ., 38(2): 98-113.

Selwyn B (2010). Gender wage work and development in North East Brazil. Bull. Am. Res., 29(1): 51-70.

Taylor FW (1911). The Principles of Scientific Management. Ed. Harper and Bros, New York, p. 127.

Udry C, Hoddinott J, Alderman H, Haddad L (1995). Gender differentials in farm productivity: Implications for household efficiency and agricultural policy. Food Policy, 20(5): 407-423.